NRA
TIM #1

METRON AVIATION

Technologies Enabling All-Weather Maximum Capacity by 2020

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Presented at NASA Ames Research Center

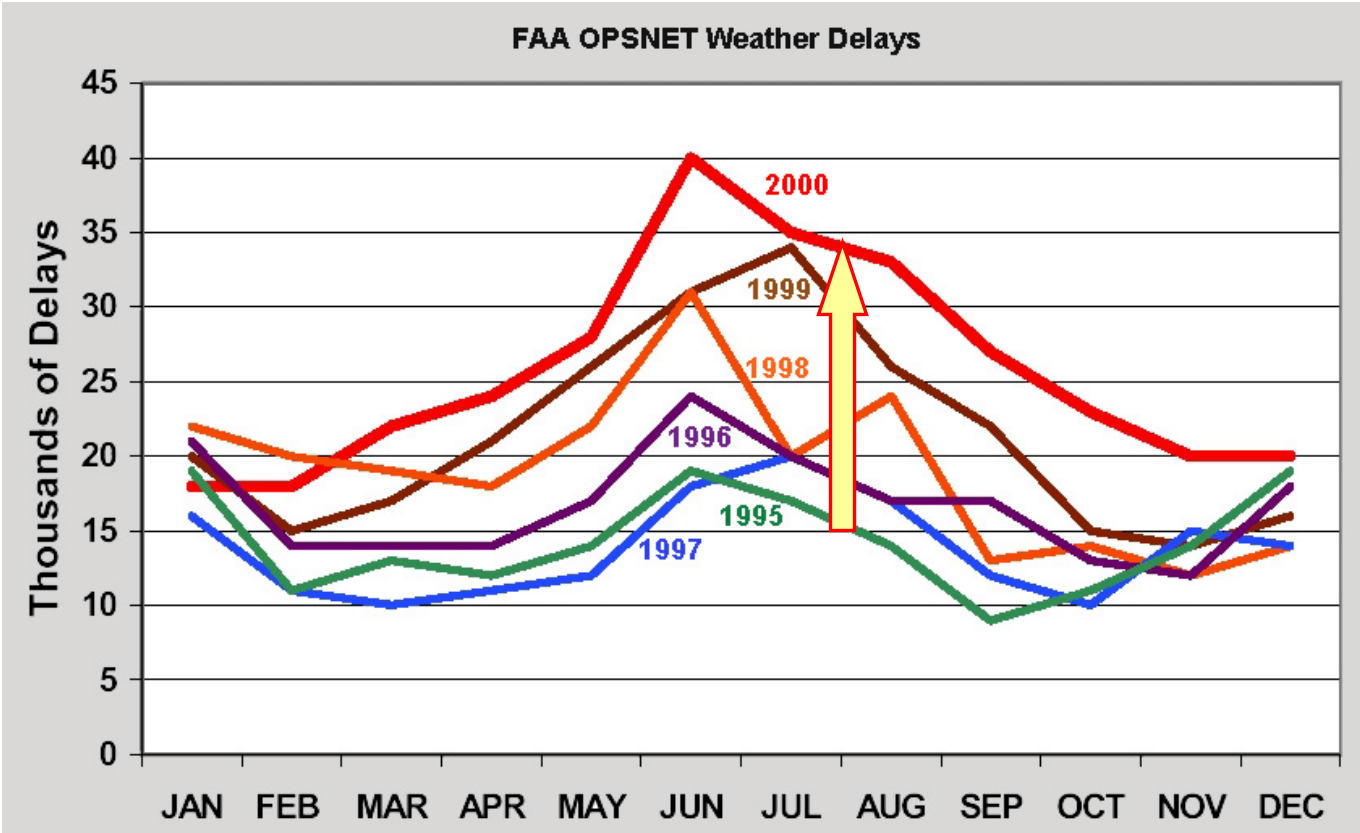
Moffett Field, CA

May 21-23, 2002

Agenda:

- Need for All-Weather Capabilities
- Who is the Metron Aviation Team?
- Core Ideas
- Enabling Technologies
- Roadmaps for New Technologies, Roles & Responsibilities
- Metrics of Goodness
- Costs/Benefits Tools and Analysis
- Motivation for Getting There

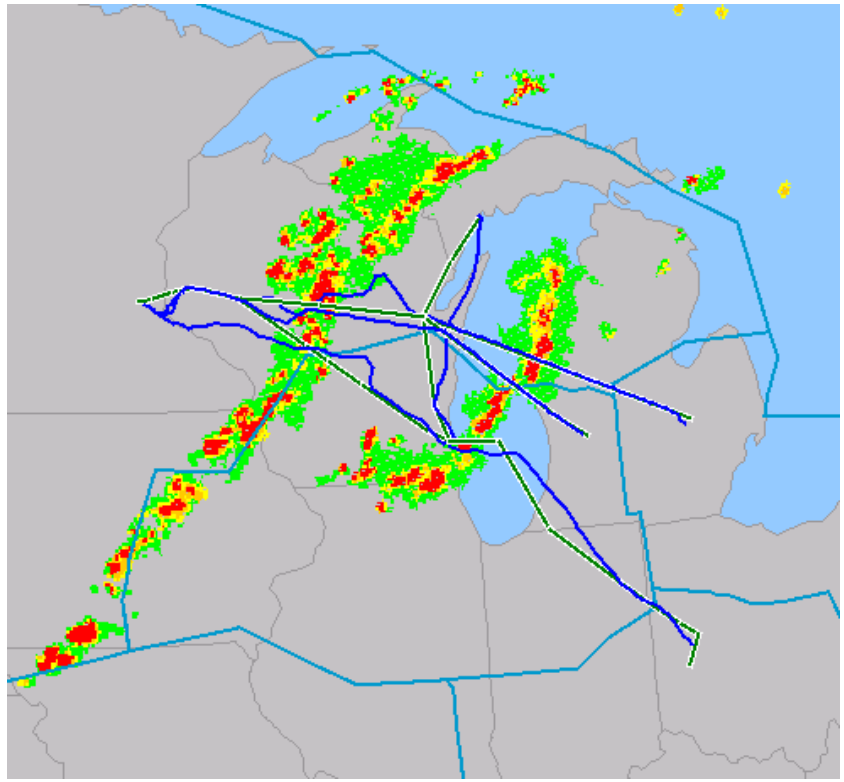
Problem: NAS is not Robust to Weather Disturbances



Weather related delays are currently increasing, especially during summer convective weather season.

Problem: Weather Reduces Capacity

- Flyable Airspace is reduced
- Stretched Paths occur as flights avoid weather
- Airspace Complexity Increases
- Workload Increases for Pilots and Controllers
- Capacity Decreases



Metron Aviation Team Topical Experts:

Principal Investigator

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Jimmy Krozel, Ph.D.
Metron Aviation
Decision Support Tools
Weather Avoidance
Algorithms

Terry Thompson, Ph.D.
Metron Aviation
Airspace Design
Noise Abatement
Route Optimization

Mike Wambsganss
Metron Aviation
Collaborative Decision Making
Traffic Flow Management

Kevin Kollman
Metron Aviation
Airline Dispatch,
Meteorology
Considerations

Tony Andre, Ph.D.
Interface Analysis
Human Factors
Human-Computer
Interfaces

THE OHIO STATE UNIVERSITY

Prof. Phil Smith
Inst. of Ergonomics
Human Factors
Roles, Responsibilities, &
Procedures

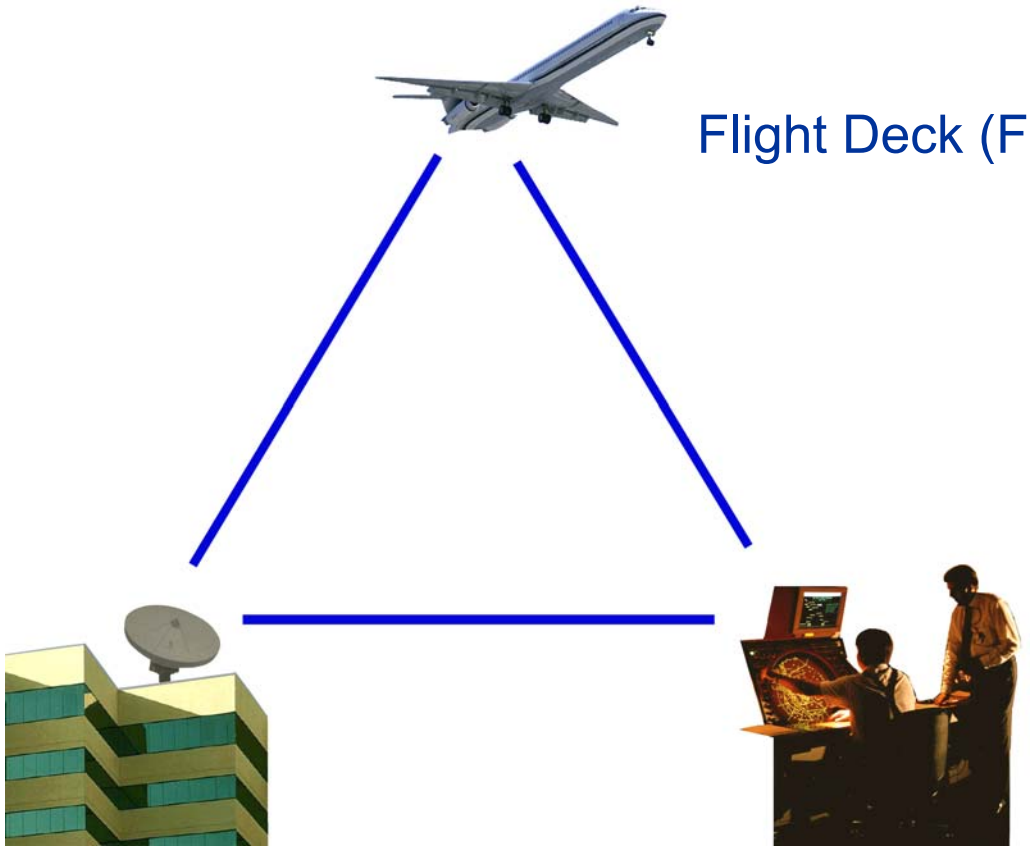
STONY BROOK

Prof. Joe Mitchell
State Univ. of NY
Computational Geometry
Weather Avoidance
Algorithms, Topology

Approach:

- **Systems Level Approach – a focus on distributed systems with competing goals and priorities**
- **Data Driven based on real NAS data to understand problems**
- **Human Centered Design Philosophy – an architecture that balances cognitive complexity constraints of human decision makers with the support of automation in terms of required Decision Support Tools (DSTs)**
- **Theoretically Founded and demonstrated Algorithms**
- **Capacity Driven:**
  - **Increasing Total Capacity**
  - **Identifying Lost Capacity & Making Best use of the Available Capacity**

The Triad:

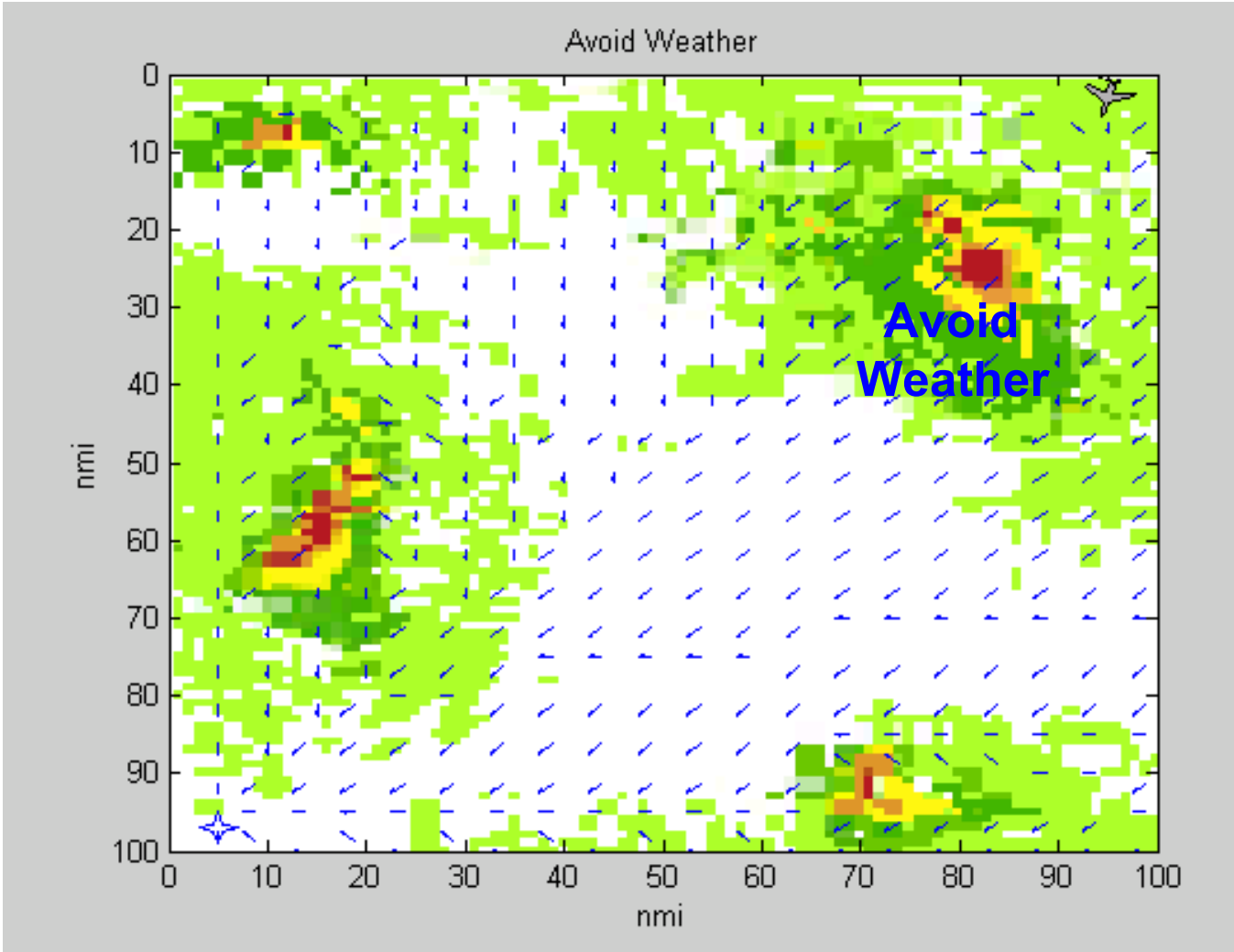


Flight Deck (FD)

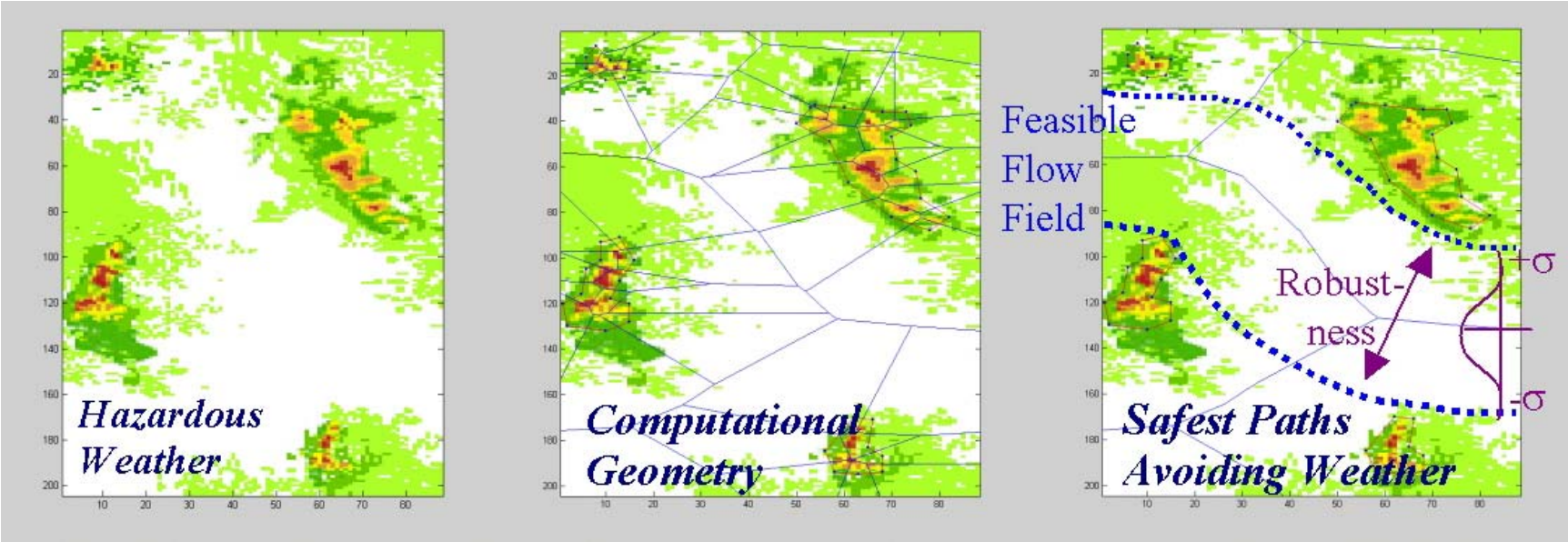
Airline Operational Control (AOC)

Air Traffic Service Provider (ATSP)

Core Idea 3 (a): Optimal Weather Avoidance

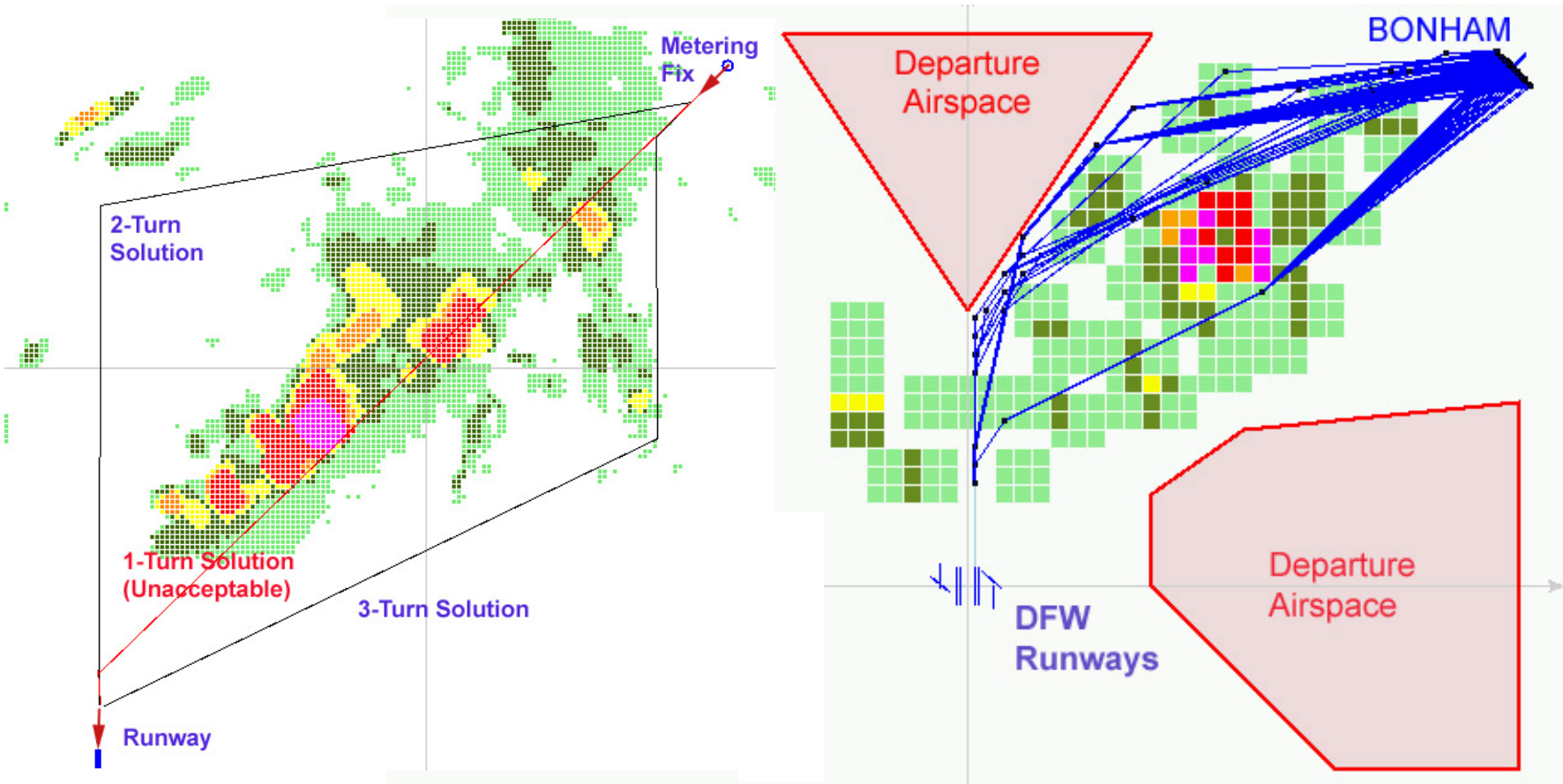


Core Idea 3 (b): Robust Weather Avoidance



A *robust* route planning algorithm identifies sets of viable routes with the same topology, given uncertainties in aircraft and weather position information.

Core Idea 7: Incorporate Weather Predictions into ETAs



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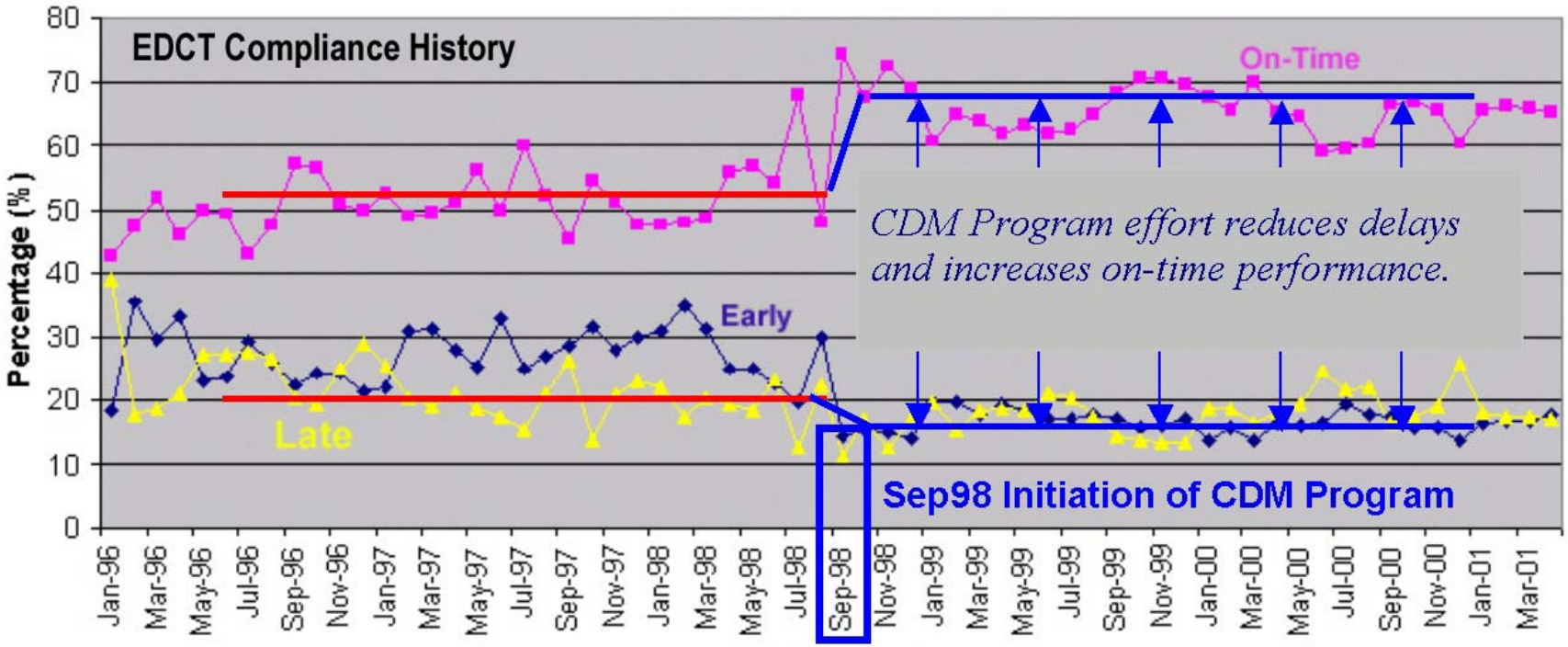
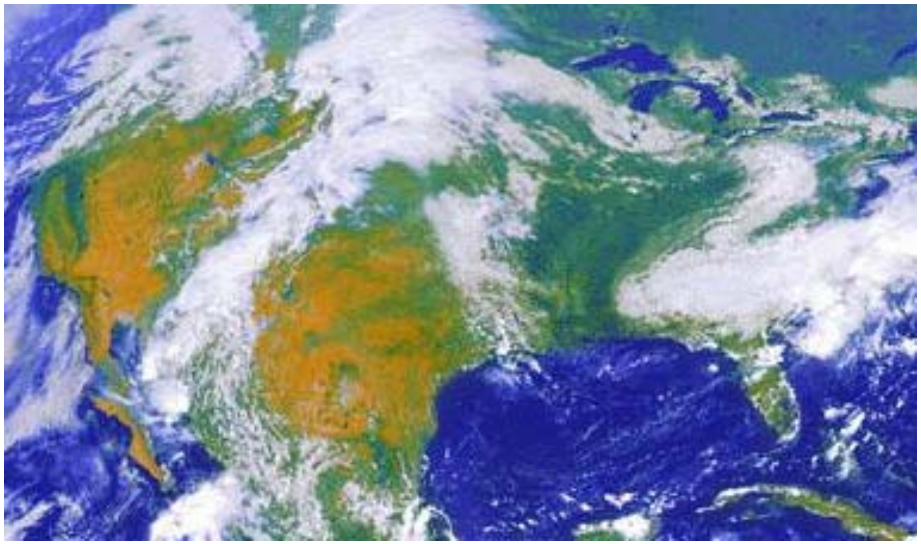
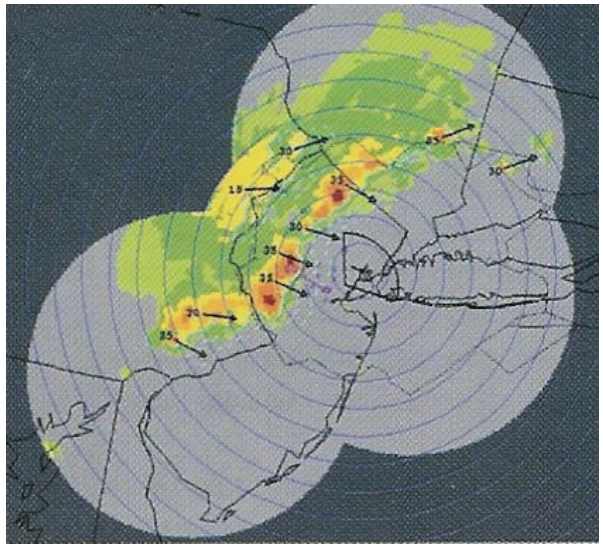
Core Idea 11: Accommodate Maximum Information Availability for CDM



CDM has been shown to increase predictability through information exchange, increasing NAS on-time performance.

Enabling Technology 1: Weather Sensing and Prediction





Weather Sensing/Prediction will completely mosaic the NAS by the year 2010.

Enabling Technology 4(a): New Displays for ATSP

New displays for ATSP will enable capacity benefits by allowing aircraft to land safely in adverse weather conditions.

Enabling Technology 4(b): New Displays for the FD

New displays for the FD will enable capacity benefits by allowing aircraft to land safely and taxi in adverse weather conditions.

Enabling Technology 4(b): New Displays for the FD

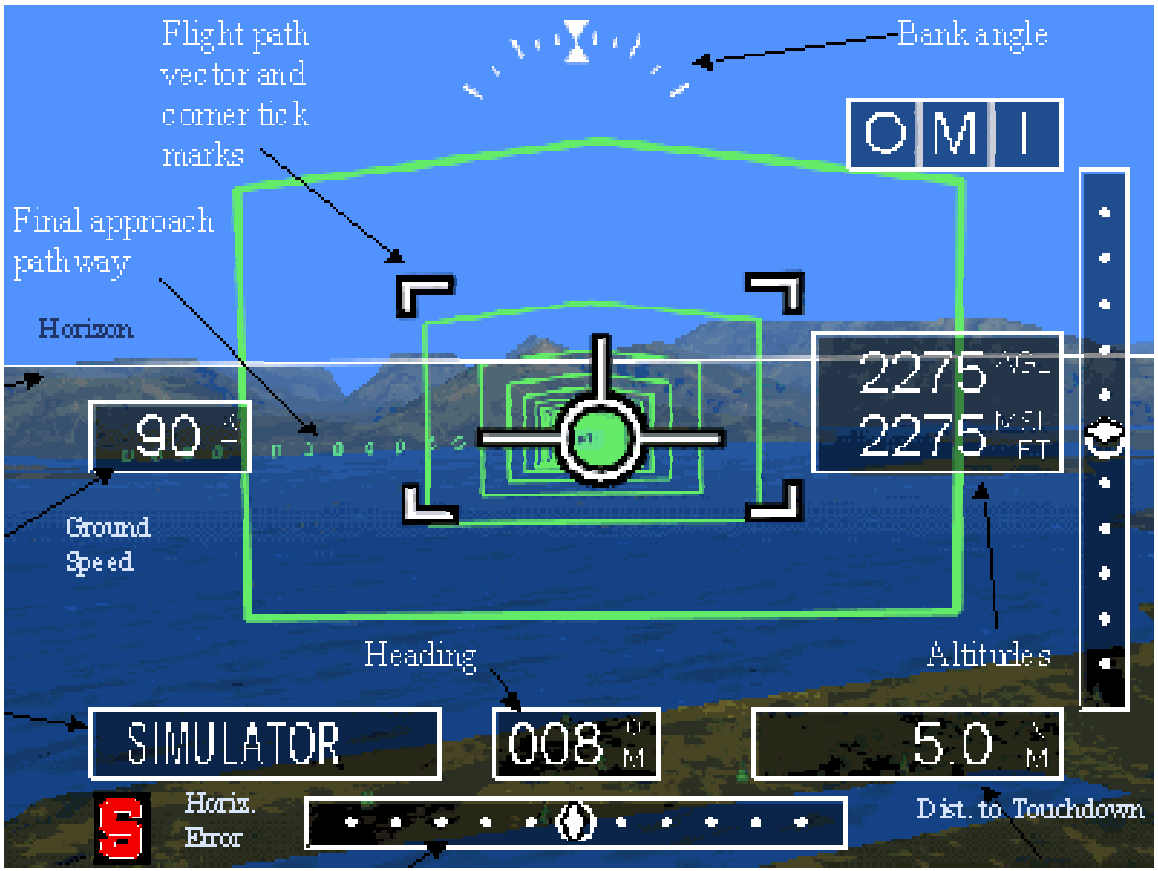
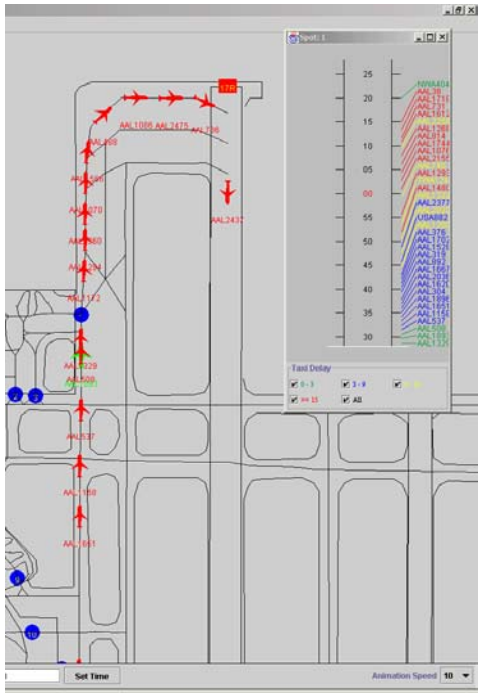
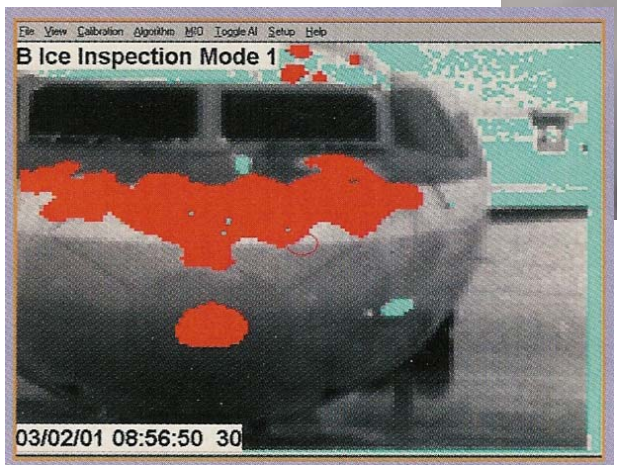


Image Courtesy of Stanford GPS Lab

New displays for the FD will enable capacity benefits by allowing aircraft to accurately follow weather avoidance routes.

Enabling Technology 5: Efficient Surface Automation



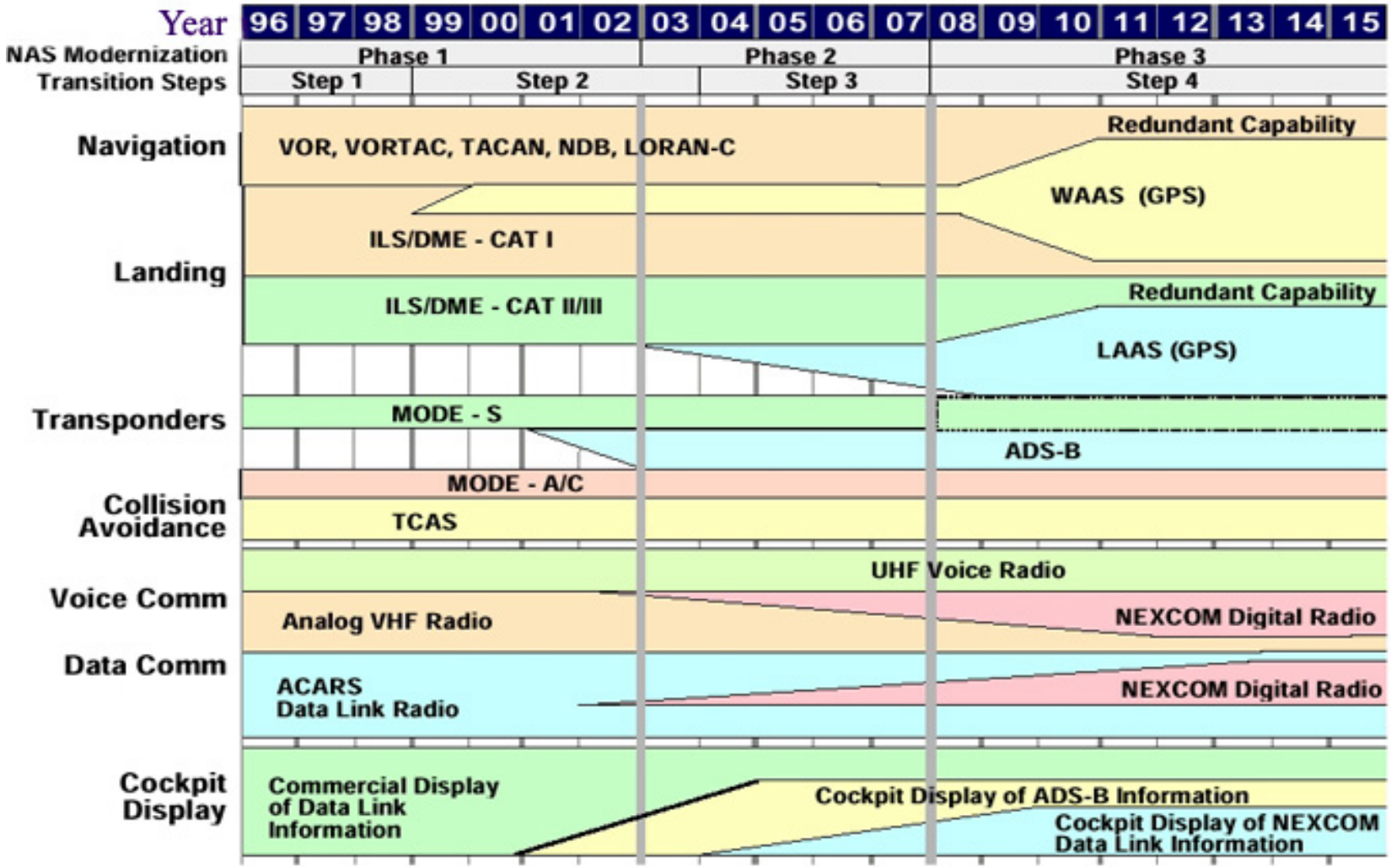


New surface automation concepts will enable faster turn-around even in adverse weather conditions.

Metrics of Goodness:

Metric	Category	Description
Capacity	Airport Capacity	Maximum number of operations, departures, and arrivals per hour (assuming steady-state)
	En Route Sector Capacity	Maximum number of aircraft within a given sector per hour, subject to workload constraints (pilot for DAG-TM concept; controller for ATSP concept)
Flexibility	User Preference	Accommodation of user preferences measured in terms of trajectory interruptions due to aircraft conflicts or weather deviations
Efficiency	Direct Operating Cost (DOC)	A metric determined by a combination of time and fuel
Predictability	Airport Time of Arrival (Departure) Prediction	Error in wheels on time (off time) as a function of prediction horizon time
	Sector Demand Prediction	Error in sector count as a function of prediction horizon time
Safety	Weather Exposure	Dwell time in hazardous weather
	Conflict Alerts	Trajectory deviations due to Conflict Detection
	Workload	Dynamic Density Complexity Metrics
Environment	Noise	Average annual noise exposure
	Pollution	Annual emissions of fuel-burn products
Delay	Average Delay	Average difference between planned arrival time and actual arrival time
	Average Block Time	Average time for gate departure to gate arrival

Technology Roadmaps:



Other Roadmaps

Roles & Responsibilities:

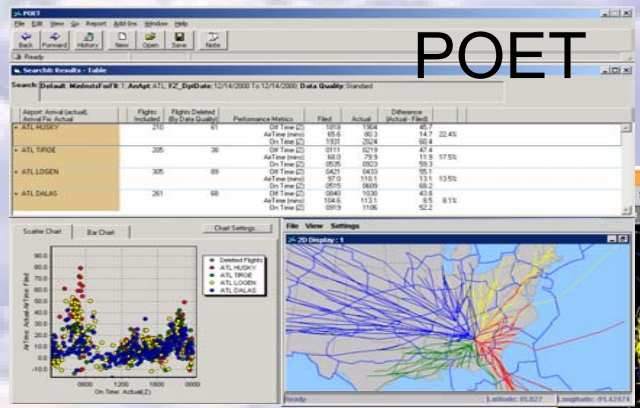
- Information Requirements
- Human / Automation Boundaries
- Transitional Plans

Scenarios:

- Current NAS Baseline
- DAG-TM
- Automated Airspace Concept
- Transitional Plans

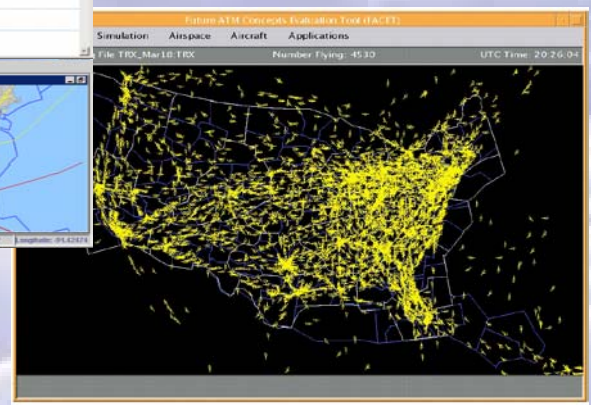
Costs/Benefits

- **Tools**
  - POET
  - FACET
  - NIRS
  - ADEPT
- **Analysis**
  - Historical, 2000, 2010, 2015, 2020
  - Metrics of Goodness
  - Scenario-Based
  - Iterative Improvement on Capacity Improving Concepts

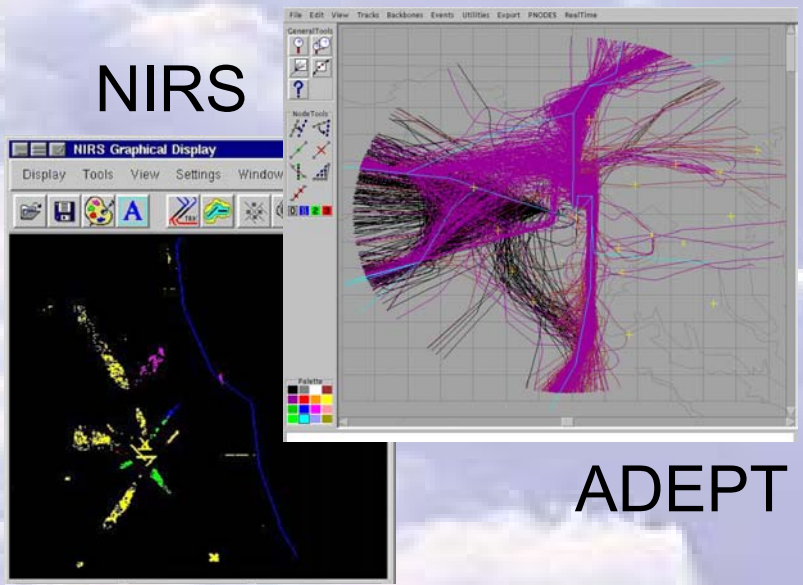


POET

FACET

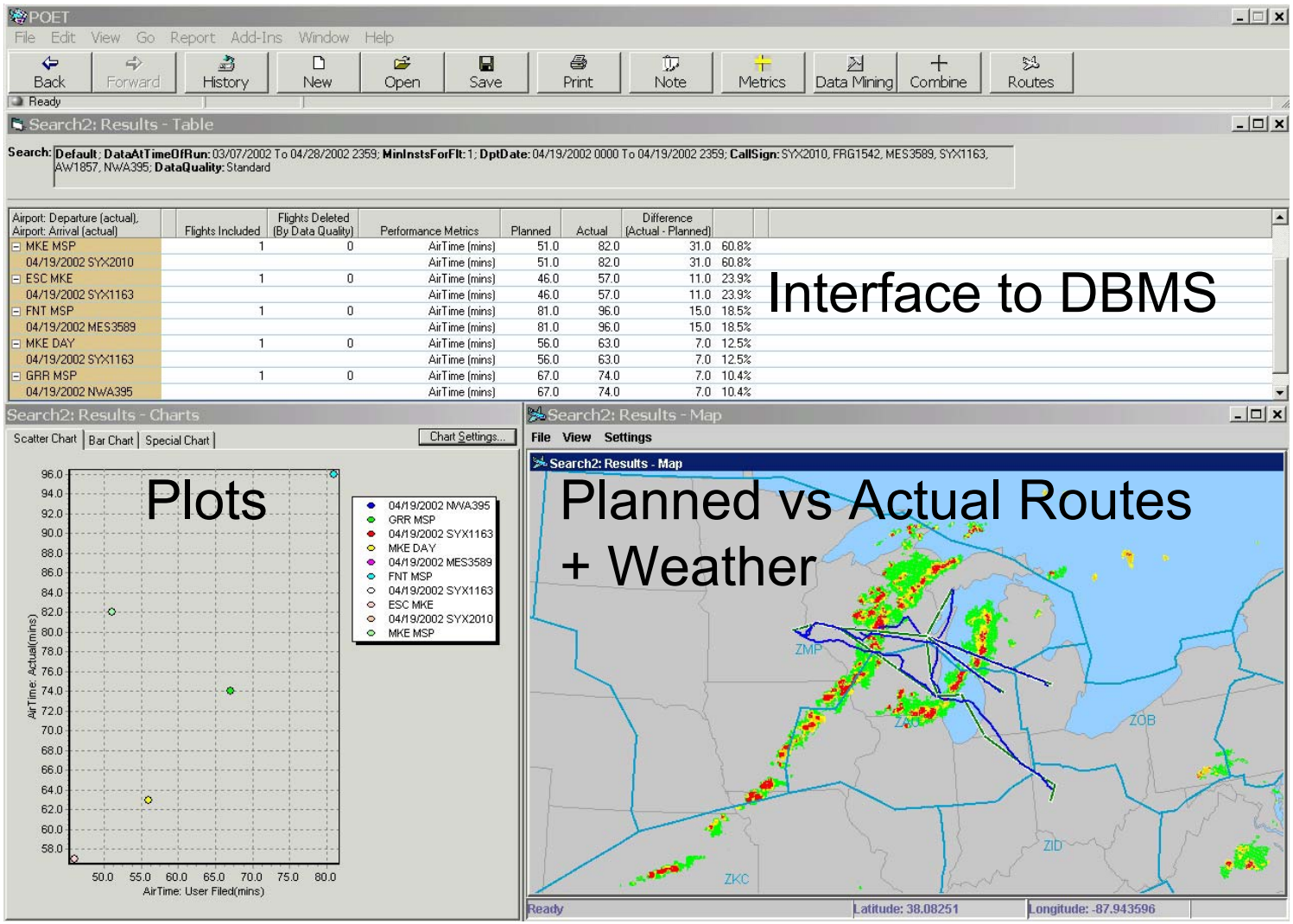


NIRS



ADEPT

Example Analysis with POET



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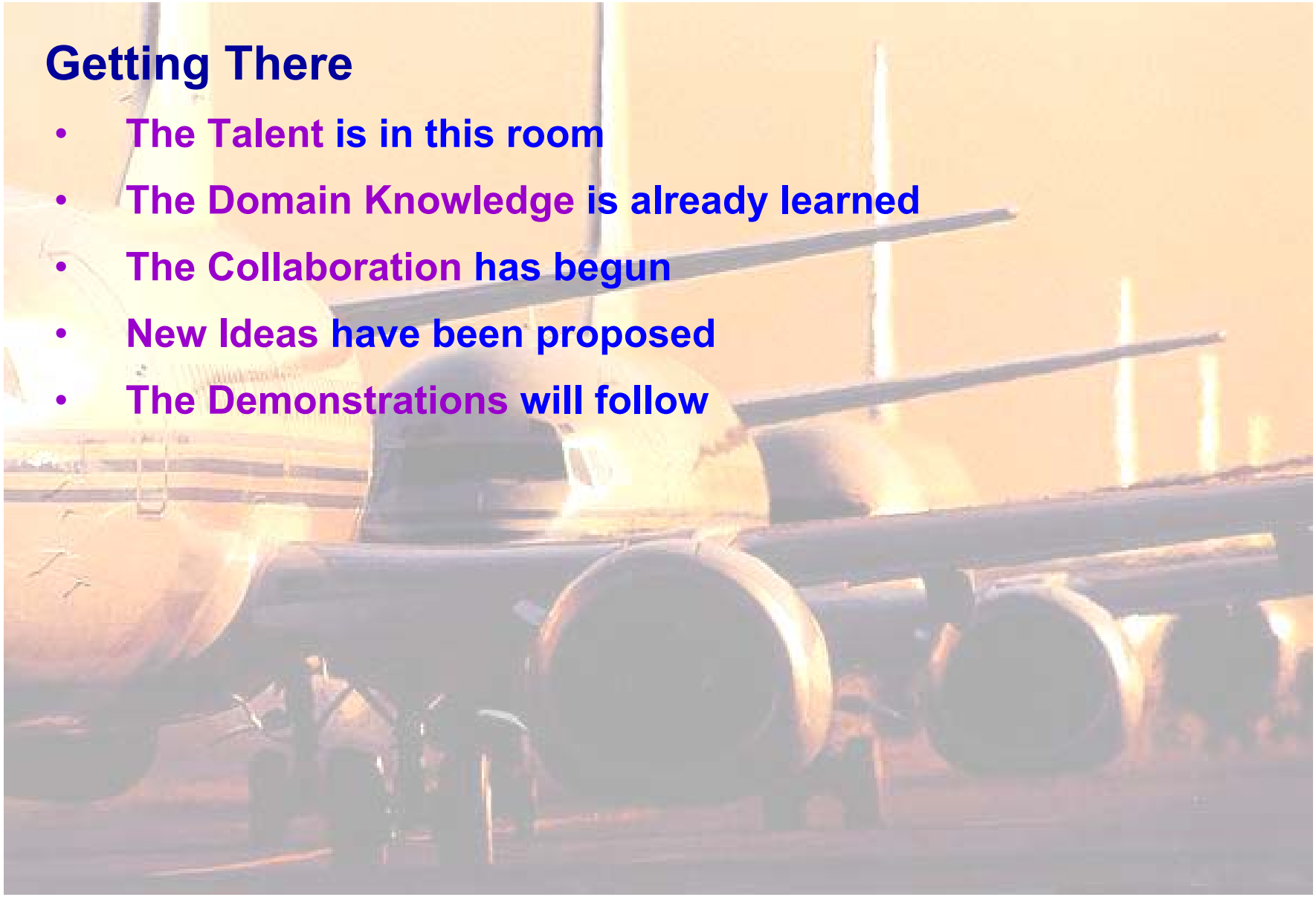

Getting There

- The Talent is in this room
- The Domain Knowledge is already learned
- The Collaboration has begun
- New Ideas have been proposed
- The Demonstrations will follow